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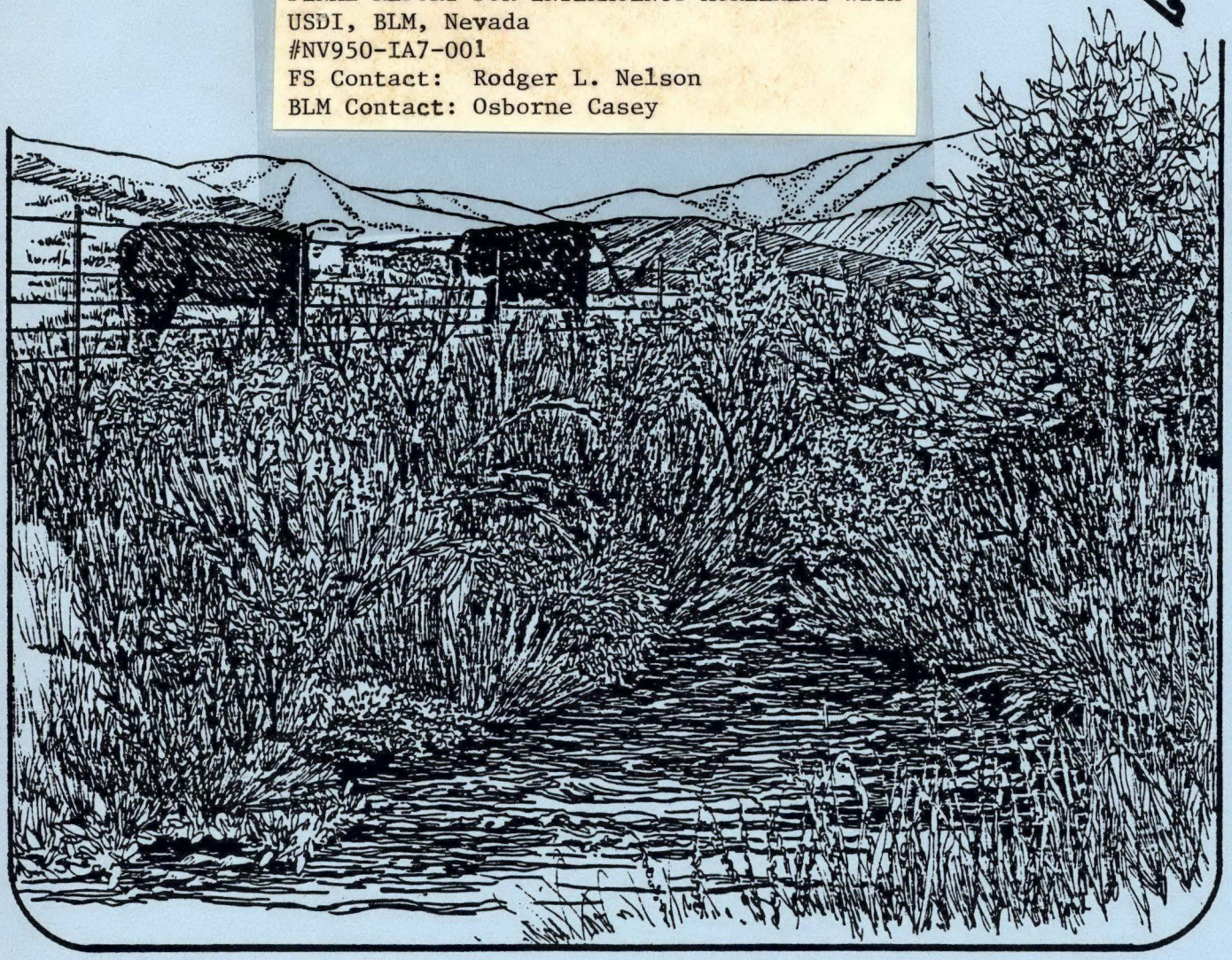
Livestock-Fishery Interaction Studies

TABOR CREEK
CHIMNEY CREEK
COTTONWOOD CREEK
DEER CREEK

FINAL REPORT FOR INTERAGENCY AGREEMENT WITH
USDI, BLM, Nevada
#NV950-IA7-001
FS Contact: Rodger L. Nelson
BLM Contact: Osborne Casey



LIVESTOCK-FISHERY INTERACTION STUDIES

JOB COMPLETION REPORT FOR

TABOR CREEK
CHIMNEY CREEK
COTTONWOOD CREEK
DEER CREEK

Presented To:

United States Department of the Interior
Bureau of Land Management
Nevada State Office
Reno, Nevada

Interagency Agreement NV950-IA7-001

1979 to 1988

Craig R. Contor
Rodger L. Nelson
Warren P. Clary

USDA-Forest Service
Intermountain Research Station
Forestry Sciences Laboratory
Boise, Idaho

EXECUTIVE SUMMARY

The Bureau of Land Management, Nevada State Office, and the U.S. Forest Service, Intermountian Research Station, have been engaged in a cooperative research project on several streams in Elko County, Nevada since 1979, including: Tabor, Chimney, Cottonwood, and Deer Creeks. The livestock-fishery interaction study monitored and evaluated the effects of continuous rest, in comparison with the normal grazing system and with rest rotation, on riparian-stream features within and adjacent to exclosed pastures.

After 1986, data collection efforts were directed at classification. Jensen's (Jensen et al. 1989) report, which includes Tabor, Cottonwood, and Deer Creeks, outlines the geologic districts, landtype associations, valley bottom types, land forms, and riparian types. Jensen's report is included as a three part supplement to this report.

Fish populations in Deer and Cottonwood Creeks were related to environmental conditions. Canopy cover was related to fish abundance overall (Platts and Nelson, in press), and the larger fish were generally collected near concealment cover. However, fish populations in Tabor Creek did not appear to relate directly to the measured features. Hatchery influences and heavy angling pressure may have masked the fish-habitat relationships in Tabor Creek. Another possibility is that the improved conditions inside the small livestock exclosures did not counteract the influences from the rest of the watershed (e.g. lack of thermal cover, high sedimentation, and altered flow regimes).

Because the studies on each stream were short, had changing objectives, and did not have consistent treatment, the data collected could not be used to meet the original objectives. However the data serves as an excellent base line for future work. Extensive tables have been included in this report to supplement others found in earlier progress reports so the data will be available in summarized form. Important findings resulting from these studies have already been published or are in the process of being published. At the back of this document, we have included a list of the products that have resulted in whole or in part from studying these four streams.

We recommend maintaining the complete rest of all the exclosures. In the future, management and research may need areas that have been rested continuously for long periods. If the exclosures are removed, they would no longer be available should the need for continuously rested sites become acute.

Together these four studies increased the understanding of recovery processes of riparian habitats. Most of the new information has been presented to researchers and managers in publications and presentations that involved these streams individually or with results from other studies that are dispersed throughout the Great Basin and the Northern Rocky Mountains. We feel that these projects have been very profitable for researchers and managers alike. We are pleased to have been a part of them.

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INTRODUCTION

Livestock-fishery interaction studies began in Nevada, during the summer of 1979, pursuant to Interagency Agreement NV950-IA7-001 (and amendments) between the U.S. Forest Service, Intermountain Research Station, and the Bureau of Land Management, Nevada State Office. The studies were initiated to identify, analyze, and monitor riparian, aquatic, and fishery conditions in Tabor Creek in Elko County, Nevada, as influenced by current and historic livestock grazing patterns.

The scope of the study was expanded to include Chimney Creek with the construction of a new live stock exclosure in 1981, allowing observation of riparian response to complete rest from grazing from its onset. Researchers attempted to rehabilitate the riparian system on Chimney Creek by planting grass, forbs, and woody plants. The Cottonwood Creek study (1985-1986) was added to establish base-line data for future evaluation of the rehabilitation of this highly degraded system. The addition of a single year evaluation of Deer Creek (1986) was intended to allow an in depth look at an area that had been completely rested for nine years and contrast it with adjacent grazed sites. However, reduced grazing outside the exclosure and grazing within the exclosures greatly reduced the utility of this comparison.

When these projects were started, the physical and biological processes of riparian degradation were known but inadequately documented. Other than complete rest, the techniques required to reverse degradation were poorly developed; a situation due, in part, to a lack of valid and standardized monitoring techniques and the required long-term data bases from which to draw conclusions.

Overgrazing streamside zones was a known source of riparian and aquatic habitat degradation, but the proposed mechanisms of habitat degradation were not completely understood. These studies examined direct physical modification of key streamside features, including:

(1) streambank shearing and slumping, resulting in a direct loss of trout cover;

(2) removal of streamside vegetation, leading to reduced bank stability with increased erosion and instream sedimentation;

(3) reduction of stream canopy, resulting in increased stream temperature fluctuations and cover loss;

(4) channel widening, leading to increased width-depth ratio and decreased pool-riffle ratio.

The livestock-fishery interaction studies on these four streams were part of a comprehensive research effort in the intermountain portion of the western United States that was designed to develop, test, and integrate an array of field observations with computerized analysis techniques for monitoring time trends in riparian and aquatic habitat characteristics and fish populations. These studies were conducted on streams in Idaho, Nevada, and Utah, and incorporated a wide range of geomorphic, riparian, aquatic, and climatic conditions, as well as a variety of fish species.

The primary objectives of these studies were in accordance with the Livestock-Fishery Interaction Studies and included:

(1) Evaluate the current grazing strategies used on the allotments relative to stream-riparian habitat conditions;

(2) evaluate the rehabilitative potential of streams relative to past, present, and potential grazing strategies and riparian rehabilitation measures;

(3) develop standardized monitoring and evaluation techniques for riparian and stream systems;

(4) begin the classification of stream-riparian habitat.

SITE DESCRIPTIONS AND ACKGROUNDS

Tabor Creek

Tabor Creek is a perennial tributary of the Mary's River. The Mary's River Sub-basin is in Elko County, Nevada, north and east of Deeth, Nevada. The Mary's River joins the Humboldt River near Deeth (Figure 1). Descriptions of the physiography, vegetation, climate, ecological province, habitat types, habitat conditions, grazing history of the Tabor Creek Allotment are covered in detail in earlier progress reports.

The Tabor Creek study was established in 1979 and continued through 1985, although the exclosure had been in place since 1968 (gates left open until 1976). The area inside the exclosure had not been grazed from 1976 to 1982. An experimental design change in 1982 created two additional exclosures around Sites 1 and 3. Site 2, (rested since 1976), was grazed under a rest-rotation strategy beginning in 1982 (Figure 3). Sites 1 and 3 (previously heavily grazed) were rested beginning in 1983. The grazing history of each site under the two experimental designs is summarized in Table 1. It is important to realize that the rest-rotation experiment began with dissimilar habitat conditions between treatment pastures, this limits the utility of making comparisons between sites in regard to the effects of rest rotation grazing without additional data collection.

Chimney Creek

Chimney Creek is a second order tributary of the Mary's River with a native cutthroat trout population. The system is on public land administered by the Elko District of the Bureau of Land Management (BLM) as the Deeth Allotment. Descriptions of the vegetation, climate, ecological province, habitat types, habitat conditions, grazing history of Chimney Creek are detailed in earlier progress reports.

The Livestock-Fishery Interaction Studies were expanded to include Chimney Creek in 1981 in cooperation with the BLM in order to quantify and evaluate aquatic and riparian habitat, fish populations, and rehabilitation potential of Chimney Creek through revegetation and complete rest from grazing. Cattle were grazed on the Deeth Allotment in accordance with normal management in 1981, but in 1982 and 1983, the permittee elected not to exercise his grazing privilege. In 1984, grazing occurred at insignificant levels. Extreme low flows occurred in the first year of the study (1981) but high flows in 1983 and 1984 dramatically changed the aquatic and riparian habitat through extensive streambank erosion and bedload movement.

The Chimney Creek study area is at an elevation of about 6,400 feet (1,951 m). The riparian zone was typically narrow, with terrestrial vegetation approaching the water's edge in many places; exposed ground was common. The three 600 ft (183 m) Chimney Creek study sites were within an 1,800 ft (550 m) reach with gentle meanders in a relatively broad channel (Figure 4). The central study site was fenced in 1981 to exclude livestock beginning in 1982. In 1982, aspen seedlings and a mixture of riparian shrubs and desirable range grasses were distributed evenly throughout the 1,800 ft (550 m) study area to help evaluate the rehabilitative potential of the Chimney Creek ecosystem under rest and grazing treatments.

In the past, Chimney Creek was not regarded as a suitable fishery, and it has not been stocked with trout. However, the upper reaches of Mary's River were stocked with cutthroat trout in the 1950s. While general watershed conditions in the upper Mary's River drainage were degraded and not conducive to trout fisheries, Chimney Creek did contain native cutthroat trout. Chimney Creek is a valuable spawning and rearing stream for native Humboldt cutthroat trout (*Salmo clarki ssp.*) a geographic race similar to, but distinguishable from, the chiefly lacustrine Lahontan cutthroat trout (*Salmo clarki henshawi*) (Behnke 1979; Behnke and Zarn 1976), though not formally recognized.

Cottonwood Creek

North Fork Cottonwood Creek is in the Jarbidge Mountains in northeast Nevada. The watershed above the project area is about 6.2 miles (10 km) (Jackson 1985). Cottonwood Creek is a tributary to Salmon Falls Creek of the Snake River

Drainage (Figure 1). The underlying geology is predominantly tuffaceous sedimentary rock. The creek flows through a narrow zone of shallow alluvial material with a channel gradient of 1-2 percent. The alluvial material is characterized by sand and silt overlying coarse gravel and cobble. Past beaver activity is evident; beaver dams and dense vegetation are considered the agents for the historic trapping and storage of fine sediments (Jackson 1985). The condition of the North Fork Cottonwood Creek in the project reach has been greatly influenced by chronic grazing by livestock which reduced or eliminated the capacity for the vegetation to stabilize fine soils. During a 100 year runoff event in the spring of 1984, the channel downcut (2 to 6 feet) to the depth of the more stable coarse gravel-cobble layer. The confinement of the flood flows within the channel (as a result of downcutting) in combination with unstable streambanks allowed extensive erosion and lateral movement of the stream. Potentially productive riparian soils were replaced by cobble, coarse gravel banks, and point bars.

In 1984 a fence was built to exclude livestock from a portion of the riparian area. Two study sites were placed inside the exclosure and two outside the exclosure (Figure 5). Data were collected in 1985 and 1986.

The objective of the study was to track the rehabilitation of stream-riparian features in a chronically overgrazed system that had "blown out" during extreme flood flows in 1983 and 1984. The data collected provides excellent base-line data for future evaluations.

Deer Creek

The West Fork of Deer Creek is on the north end of the Snake Mountain Range, 22 miles southwest of Contact, Nevada (Figure 1). The West Fork is within the Salmon Falls River Drainage (of the Snake River Drainage), in which salmon once spawned. Elevation on the West Fork ranges from 6,000 to 6,600 feet (1800-2000 m). Geologic features consist primarily of volcanic plains, low foothills and mountains. The native rainbow trout are poorly represented near the lower end of the stream. Brook trout dominate in the lower half of the stream and lahontan cutthroat trout dominate the upper half (Crispin, 1981).

The study area is in a canyon that is characterized by a series of remnant beaver ponds, most of which have filled with silt or washed out. Outside of the exclosure, fallen aspen were abundant throughout the canyon area. Livestock grazing has restricted aspen regeneration except in isolated patches protected by logs or steep hillsides. Only large decadent aspen remained. Groups of willows were scattered along the canyon bottom, but grasses dominated the area. The area was heavily grazed by cattle and streambanks were in poor or fair condition.

No domestic livestock grazing occurred in this area prior to 1850. Early grazing use was extremely heavy, with itinerant bands of cattle and sheep competing with local ranchers' livestock for the desirable forage. The Deer Creek pasture is 11,555 acres and had an estimated grazing capacity of near 2,495 animal units months (AUMs).

Use of the pasture has been as high as 5,000 AUM's (twice estimated capacity). Actual AUM's exceeded the estimated capacity throughout the 1970's. (Crispin 1981).

A fence was built in 1977 to exclude livestock from 0.6 miles (1 km) of stream (Figure 5). Four log dams were built in the meadow at the lower end of the exclosure to provide quality pools for trout habitat. Crispin (1981) reported dramatic increases in fish populations and desirable stream-riparian features after just 3 years.

Grazing outside of the exclosure in the 1980s was reduced from the 1970s levels to an amount below the estimated grazing capacity of 2,495 AUM's. Grazing inside the enclosure occurred in 1981 and 1983 prior to our data collection in 1986. Because utilization and habitat damage was not assessed in 1981 and 1983, it is impossible to estimate how the reduction of grazing outside the exclosures or the grazing within the enclosures affected stream riparian features observed in 1986.

METHODS

Over the course of the study, a wide array of riparian, stream, and trout population variables were measured. These variables were evaluated annually from 1979 through 1985 to provide information on apparent as well as hypothesized trends. During the study, several variables of interest were added, some were dropped, while others were modified. Ecosystem attributes were typically measured at each transect and fell into 4 basic categories:

Structural Attributes

- Streambottom substrate materials
- Substrate embeddedness
- Water column width, depth, and width-depth ratio
- Trout cover provided by instream vegetation
- Stream shore water depth
- Pool and riffle width and pool-riffle ratio
- Pool quality and feature of origin
- Streambank angle and undercut depth
- Unobstructed sun arc

Riparian Attributes

- Streamside habitat type
- Stream cover and bank cover stability
- Forage biomass and utilization (at selected transects)
- Streambank alteration

Hydraulic Attributes

Stream cross-sectional profile
Stream gradient and water velocity

Fisheries Attributes

Fish species composition and population size, biomass, density, and condition by species (condition on trout only).

Methods are briefly described in this report. More detailed descriptions can be found in Platts et al. (1983, 1987) as well as earlier progress reports.

Structural Measurements

Structural measurements describing the physiognomy of the stream documented the changes induced by grazing and resting treatments. The measurements were taken at each transect, sorted by study site, and averaged to determine site-specific conditions; variances, standard deviations, confidence intervals (α=0.05), Student's t values, and F-ratios were also normally computed, but have not been included in this report. (Documentation of the statistical significance of differences between treatment and control sites for Tabor Creek can be found in Platts and Nelson 1983; earlier reports contain more in-depth statistical analysis).

Stream width was determined by the amount of wetted streambed directly under the transect line; width was measured to the nearest 1.0 ft (0.03 m). **Stream depth** was determined at 3 points directly below the transect line corresponding to 25, 50, and 75% of the wetted width, and divided by 4 (to account for 0 depth at the bank) to obtain the average depth along the transect; depths were measured to the nearest 0.1 ft (0.03 m). **Width-depth ratio** was computed as width divided depth for each transect. **Pools** were identified as that portion of the water column that was relatively slower and deeper than surrounding portions, and that typically possessed an unbroken surface (glides or runs included); **riffles** constituted the remainder of the wetted width. Water column habitats not clearly distinguishable as pool or riffle were classified as pool. **Pool-riffle** ratio was calculated by dividing pool width by riffle width for each transect. **Pool quality** rating was based upon width, depth, and cover characteristics in relation to the habitat requirements of trout, and was evaluated for all pools along each transect and averaged (weighted by extent of each pool) to obtain the transect rating. **Pool feature** identified the principal agents responsible for the formation of the dominant pool under each transect. **Canopy cover** was measured prior to 1984 using a clinometer to determine the unobstructed arc of the sun over the center of the stream at every fifth transect. **Thermal input** was substituted for canopy cover in 1984 and estimated potential insolation for the entire year in BTU/ft^2/day with a Solar

Pathfinder[1] at every fifth transect.

Streambank angle was measured in degrees with a clinometer at the interface between the stream and streambank to determine the downward slope of the bank to the water. Bank angles and all other bank related features were measured on each bank and averaged for each transect. **Streambank undercut** was a direct horizontal measurement to the nearest 0.1 ft (0.03 m) of the depth of the dominant undercut (if any). **Shore depth** was measured to the nearest 0.1 ft (0.03 m) at the interface between stream and streambank under each transect. **Fisheries quality** rating (measured prior to 1984) categorically ranked the apparent quality of the land-water contact zone for trout.

Streambottom surface materials were classified into five size classes, and the extent of each size class was measured to the nearest foot under each transect. Size classes were defined as: **small fines**, those particles smaller than 0.033 in (0.83 mm) in diameter; **large fines**, those particles larger than small fines but smaller than 0.19 in (4.75 mm) in diameter; **gravel**, those particles larger than large fines but smaller than 3.0 in (76.1 mm) in diameter; **rubble**, those particles larger than gravel but smaller than 12.0 in (305.0 mm) in diameter; and **boulders**, all larger particles. **Embeddedness** estimated the gasket effect of large and small fines surrounding larger particles.

Riparian Habitat Evaluation

Streambank-riparian features hypothesized to influence trout survival were measured after or near the end of the grazing season. **Stream cover** was a ranking based on dominant growth form (tree, brush, herbaceous, or exposed) on each bank from the water's edge and back 5 ft (1.5 m), and averaged for each transect. **Bank cover stability** rated the coverage of the bank under each transect line, from the water's edge and back 5 ft (1.5 m), by vigorous plant growth or substrate particles larger than fines that would reduce bank erosivity; it was a categorical ranking prior to 1984, when it was replaced by a measurement of actual percent cover. **Vegetative overhang** measured the distance along the transect to the nearest 0.1 ft (0.03 m) that had vegetation 1 ft (0.3 m) or less above the stream surface. **Streambank alteration** was a qualitative estimate of the deviation, in percent, of the streambank from natural optimum conditions. **Habitat type** evaluated riparian features (in a trout-related sense) under the transect line from the water's edge and back 10 ft (3.0 m) based on the dominant and subdominant mineral or vegetation characteristics (e.g. brush/sod, which

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1 (NOTE: The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.)

ranked highest, and sand/sand, which ranked lowest). **Vegetation use** by livestock was estimated visually, in percent, under each transect from the water's edge and back 5 ft (1.5 m). Estimation of forage use was supplemented by measurements of **streamside herbage** production with an electronic capacitance herbage meter (Neal Electronics Model 18-2000 or 18-3000) which allowed non-destructive measurement of standing forage in sample plots on selected transects.

Fish Population Analysis

Fish populations were sampled with battery powered variable-voltage, pulsed DC electrofishers. Trout were individually identified, counted, measured to the nearest 0.04 in (1.0 mm), and weighed to the nearest 0.04 oz (1.0 gm); non-game fish were counted and weighed in bulk by species. We used a removal-depletion maximum likelihood model with four successive removals to estimate the actual populations of each species. Population statistics generated included: total catch, estimated population size, mean length, mean weight, estimated population density, estimated biomass, and mean population condition factor. More rigorous statistical treatment of sampling efforts, including confidence intervals ($\alpha=0.05$) can be found in previous reports in this series; supplemental information can be found in Platts and Nelson (1988).

RESULTS AND DISCUSSION

This cooperative project between the Intermountain Research station and the Bureau of Land Management was a long and profitable one. Considerable advancements were made in understanding the restoration processes of degraded stream-riparian systems, as well as the development of methods to better assess and monitor aquatic and riparian conditions.

The project met the objective of fine-tuning both monitoring and assessment techniques for stream-riparian systems. The results also support the hypothesis that grazing was degrading the stream-riparian habitat of these streams. Complete rest promoted the recovery of these systems.

We caution against the logical assumption that applying future results from the rest-rotation study on Tabor Creek to an allotment-wide management strategy would yield the same recovery as in the test pasture (Site 2). The riparian area inside the enclosure is a much larger proportion of the test-pasture than is the outside riparian area in relation to the entire allotment. In addition, use is much higher on riparian and stream areas in relation to upland areas (Platts and Nelson 1985a, 1985b; Roath and Krueger, 1982). Furthermore, several cattle generally use a small pasture more evenly than many cattle using a large pasture because of home-area behavior (Platts and Nelson 1985c). Therefore, the stream-riparian area in the entire allotment might not respond at the same rates as in the test-pasture because a disproportionately

smaller riparian area will be used by a disproportionately larger number of cattle.

The concept and recommendation to have four to six inches of stubble remaining along riparian areas at the end of each grazing season (Clary and Webster, 1989) should be suitable for these systems. However, it is unclear what level of use would leave four inches of stubble in the riparian area and along the stream banks. There is a need to continue careful tracking of actual grazing levels and how the rest-rotation strategy affects the previously rested sites. Basically, the concept is that four inches of stubble is needed to maintain plant vigour and soil building sod and to allow woody species to regenerate and grow. Furthermore, longer stubble insulates the soil and may reduce and prevent freeze-thaw cycles in the winter that can severely damage streambanks (Bohn, 1989).

Tabor Creek

Within the exclosure, Tabor Creek had already undergone some riparian rehabilitation when this study began in 1979. By 1982 it was clear that complete rest had initiated and enabled a progressive cycle of streambank-riparian restoration. Vegetation encroached on previously exposed sand and gravel bars and unstable stream banks. Sediments deposited among pioneering plants provided rooting areas for more vegetation. Additional plant growth trapped more sediment. This bank building process protects against direct physical erosion by water flows, and insulation against freeze-thaw cycles in winter that can break down streambanks. The increased growth and encroachment of the streambank vegetation also provides increased shading, increased overhead cover, reduced stream width, and increased stream depth. The lack of grazing inside the exclosure was clearly an agent for these improvements.

Tabor Creek, in its current state, has excellent potential for rehabilitation; however, further degradation may bring the system to a state of high risk such that a peak-hydraulic event may drastically move the channel, remove streambank and riparian soils, and/or incise a deep channel to such a extent that rehabilitation will be extremely long as has occurred on Chimney Creek (Platts et al. 1985a; Platts et al. 1985b).

In 1982 the study emphasis was changed to examine the effects of a rest-rotation strategy relative to complete rest; however, data were not collected beyond the first cycle or rest rotation and little can be gleaned from the data at this point. Additional data should be collected after the third or fourth cycles in 1990 or 1993.

The rest-rotation study results showed few trends in three years (1983-1985). Vegetation overhang, however, increased dramatically in sites 1 and 3, from 0.5 inches (1 cm) in 1982 to 16 in (40 cm) in 1985 in site 1. Vegetation overhang decreased in site 2 (Tables 2, 3, 4, and 5). The importance of overhanging vegetation on Tabor Creek in relation to the structure and integrity of the streambanks is unknown, but it may indicate good plant vigor and increased bank stabilization. It is important to note that site 2 had been completely rested for six years prior to 1983 and sites 1 and 3 had

been grazed season long and were quite degraded (Figure 3 and Table 1).

Tabor Creek contained mostly rainbow trout with a few brook trout, sculpin, sucker, and dace. Fish population characteristics in Tabor Creek are heavily influenced by human practices. Large fluctuations in species composition, numbers, and average size are influenced by fishing pressure, grazing influences, and present condition of the drainage up and downstream from the site. In addition, trout populations in Tabor Creek have been influenced by hatchery stocking of 10 in (25 cm) rainbow trout. It is unknown how hatchery fish and angling influenced wild trout or total trout numbers. Stocking can reduce trout numbers in streams (Vincent, 1988). The importance and magnitude of the above influences are unknown for Tabor Creek fish populations.

Chimney Creek

Because cattle were absent from the Chimney Creek study area in 1982 and 1983, and grazing was insignificant in 1984, the data set serves as a baseline and documents the differences between sites for later investigations. The data set also follows a degraded system through a period of extremely high flow events (Tables 6, 7, and 8). This base line data could be used to document the rehabilitation sequences and time frames for degraded "blown out" streams under several possible treatment strategies.

Chimney Creek, like most degraded systems in the Great Basin is unpredictable. Extreme low flows occurred in the first year of study (1981), while flows were unusually high for next three years (1982-1984). High flows from the extremely wet years altered the streambanks and channels extensively throughout the study area (Figure 2).

The riparian zone of all three sites on Chimney Creek also suffered extreme damage. Entire banks and large areas of valley bottom soils were eroded away (Figure 2). This erosion greatly reduced the ability for riparian rehabilitation to continue. This is a typical example of what occurs in a chronically overgrazed system that experiences an extreme flow event. These events demonstrate the importance of maintaining and protecting riparian vegetation, specifically large woody vegetation as well as vigorous sod, to hold banks and riparian soils.

The events that have transpired on Chimney Creek were predictable given the condition of the uplands, streambanks, and riparian areas observed in 1981. Similar patterns can be expected for other drainages with similar degradation to both the uplands and the riparian-streambank areas.

One basic conclusion of this effort is that traditional grazing management on the Chimney Creek Allotment (Deeth Allotment) has been ineffective in promoting healthy streamside areas.

Cottonwood Creek

The two years of data collected on Cottonwood Creek provide base line data for each site for further analysis. Currently, not many conclusions can be drawn from the data except that the site was in a degraded condition in terms of bank-channel features. More trout were found in areas with the deepest water, greatest undercut banks, best pool ratings, lowest embeddedness, most vegetation overhang, most instream vegetation cover, and greatest stream cover (Tables 9, 10, 11, 12, 13).

Deer Creek

We surveyed the same area as did Crispin (1981). Inside the exclosures, Crispin (1981) found increased fish biomass, improved physical features of the stream, and increased vegetation and bank stability. Improvements in streamside vegetation increased shading and reduced stream temperatures and increased the downstream extent of the trout fishery.

While not within the exclosure, site 4 was not grazed to any great extent because topography and fences generally keep cows out of that section. Consequently, we did not consider site 4 to be representative of the other grazed sections of the valley bottom. Furthermore, less grazing in the entire allotment and trespass grazing within the exclosure confounded the study and reduced its utility.

However we did find that fish selected the under-grazed reaches over the more grazed reaches. The under-grazed reaches had greater mean depths, narrower widths, and higher quality pools. Trout densities were from 2 to 5 times higher in the under-grazed areas than in site 1. (Tables 14, 15, and 16).

SUMMARY

In general, larger trout in all streams were consistently collected during electrofishing efforts, where large woody debris and dense vegetation canopy occurred. Fish populations often correlate with abundant vegetation canopy and instream concealment cover (Platts and Nelson, in press). Contor (1989) found 96% of 1550 juvenile rainbow trout associated with concealment habitat in only 20% of the area surveyed. Continued improvement of riparian areas will increase the vegetation canopy for stream shading, increase woody debris, increase submerged concealment cover, increase stream depth, and increase bank stability. For full rehabilitation, these changes will need to occur throughout the drainage and not just within the exclosure, because water flow (duration and persistence), temperature, quality, and quantity are influenced by the conditions in the entire drainage. With respect to fish populations, conditions in the drainage may override any local improvements in the habitat features within the exclosures.

One basic conclusion of this effort is that traditional grazing management has been ineffective in promoting healthy streambanks in all study areas. Other than Deer Creek, we cannot be quite so certain as to the effect of grazing on fish populations. We suggest that the overall condition of the watershed masks any improvements in local physical features in terms of influencing fish populations.

The results of these studies have had wide application outside the original scope of the study. Several valuable products have been presented at scientific meetings and published in the primary literature and in management agency publications. Although this phase of the study has ended, we have a foundation upon which additional work could be developed.

Jensen's (Jensen et al. 1989) report is considered a three part supplement to this report because after 1985 all efforts on these studies were redirected into the classification project. Jensen's (1989) report outlines the results of the riverine/riparian habitat classification work on Tabor Creek, Cottonwood, and Deer Creek (and many other streams). The report outlines the geologic districts, land type associations, valley bottom types, land forms, and riparian vegetation types for each stream examined. This work provides a basis for management and future research on the unique riparian-stream ecosystems in the Great Basin.

RESEARCH PRODUCTS

These studies conducted on Tabor, Chimney, Cottonwood, and Deer Creek were instrumental in furthering the understanding of stream-riparian ecology with and without grazing influences. The work on these four streams comprised one portion of an integrated research effort with concurrent studies in Idaho, Utah, and Nevada. Results from the investigations were important in developing the following research publications that were direct results of analyzing data from Tabor, Chimney, Cottonwood, or Deer Creek, or combined data from these and other streams.

BESCHTA, R.L., and W.S. Platts. 1986. Morphological features of small streams: significance and function. Water Resources Bulletin. 22(3):369-379.

CONTOR, C.R., and W.S. Platts. (in prep) Assessment of the model COWFISH in streams in Idaho, Nevada, and Utah. USDA, Forest Service, Intermountain Research Station, Boise, Idaho.

JENSON, S., R. Ryel, and W.S. Platts. 1989. Classification of riverine/riparian habitat and assessment of nonpoint source impacts: North Fork Humboldt River, Nevada. Unpublished report on file, USDA, Forest Service, Intermountain Research Station, Boise, ID.

NELSON, R.L., W.S. Platts, and C.K. Graham. 1988. Relative suitabilities of linear and logarithmic regression models in electronic analysis of riparian vegetation. USDA Forest Service Research Note INT-382, Intermountain Research Station, Ogden, UT. 5p.

PLATTS, W.S. 1989. Compatibility of livestock grazing strategies with fisheries. p.103-110 In: R.E. Gresswell, B.A. Barton, and J.L. Kershner (editors). Practical Approaches to Riparian Resource Management, an Educational Workshop, Billings, MT, May 8-12, 1989.

PLATTS, W.S. 1986. Managing riparian stream habitats. In: Bergersen, E.; Calson, C.; Hannu, B., eds. Proceedings of the 21st Annual Meeting of the American Fisheries Society, 1986. Fort Collins, Colorado.

PLATTS, W.S. 1984. Compatibility of livestock grazing strategies with riparian-stream systems. In: Proceedings, 1984 Pacific Northwest range management short course: range watersheds, riparian zones and economics: interrelation-ships in management and use; Corvallis, OR: Oregon State University; 1984:67-74.

PLATTS, W.S. 1984. Riparian system/livestock grazing interaction research in the intermountain west. In: Warner, Richarc E.; Hendrix, Kathleen M., eds. California riparian systems: ecology, conservation, and productive management. Berkeley, CA: University of California Press: 1984: 424-429.

PLATTS, W.S., C. Armour, G.D. Booth, M. Bryant, J.L. Bufford, P. Cuplin, S. Jensen, G.W. Lienkaemper, G. Minshall, S. Monsen, R.L. Nelson, J. Sedell, and J.S. Tuhy. 1987. Methods for evaluating riparian habitats, with applications to management. USDA-Forest Service General Technical Report, INT-221, Intermountain Research Station, Ogden, UT. 177 p.

PLATTS, W.S., K. A. Gebhardt, and W. L. Jackson. 1985. The effects of large storm events on basin-range riparian habitats. p. 30-34 In: Proceedings of the North American Riparian Conference, April 16-18, 1985, Tucson, AZ.

PLATTS, W.S., S. Jensen, and F. Smith. 1988. Preliminary classification and inventory of riverine riparian habitats of livestock/fishery study areas, Nevada. USDA, Forest Service, Intermountain Research Station, Boise, Idaho. 100 p.

PLATTS, W.S., and M.L. McHenry. 1988. Density and biomass of trout and char in western streams. USDA Forest Service General Technical Report INT-241, Intermountain Research Station, Ogden, UT. 17p.

PLATTS, W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. USDA Forest Service General Technical Report INT-138, Intermountain Research Station, Ogden, UT. 70p.

PLATTS, W.S., and R.L. Nelson. (in press). Stream canopy and its relationship to salmonid biomass in the Intermountain West. Submitted to the North American Journal of Fisheries Management.

PLATTS, W.S., and R.L. Nelson. 1988. Fluctuations in trout populations and their implications for land-use evaluation. North American Journal of Fisheries Management. 8:333-345.

PLATTS, W.S., and R.L. Nelson. 1985. Streamside and upland vegetation use by cattle. Rangelands. 7(1):5-7.

PLATTS, W.S., and R.L. Nelson. 1983. The electronic capacitance meter: a tool for evaluating riparian-fishery habitat. North American Journal of Fisheries Management. 3:219-227.

PLATTS, W.S., R.L. Nelson, and D. Tol. 1988. Stream canopy conditions and trout biomass relationships on grazed streams in the Intermountain West. Presented at the annual meeting of the Western Division of the American Fisheries Society and Western Association of Fish and Wildlife Agencies, July 10-13, Albuquerque, NM.

PLATTS, W.S., and R.L. Nelson. 1982. Livestock-fishery interaction studies: Tabor Creek, Nevada. USDA, Forest Service, Intermountain Forest and Range Experiment Station, Boise, Idaho. 73 p.

PLATTS, W.S., and R.L. Nelson. 1981. Livestock-fishery interaction studies: Tabor Creek, Nevada. USDA, Forest Service, Intermountain Forest and Range Experiment Station, Boise, Idaho. 57 p.

PLATTS, W.S., R.L. Nelson, O. Casey, and V. Crispin. 1983. Riparian-stream habitat conditions on Tabor Creek, Nevada, under grazed and ungrazed conditions. Western Proceedings: 63rd annual conference of the Western Association of Fish and Wildlife Agencies, Boise, ID. Held 1983 July 10-14. Teton Village, WY. pp. 162-174

PLATTS, W.S., R.L. Nelson, and S.B. Martin. 1980. Livestock-fishery interaction studies: Tabor Creek, Nevada. USDA, Forest Service, Intermountain Forest and Range Experiment Station, Boise, Idaho. 37 p.

PLATTS, W.S., and J.N. Rinne. 1985. Riparian and stream enhancement management and research in the Rocky Mountains. North American Journal of Fisheries Management 5:115-125.

PLATTS, W.S., R.J. Torquemada, R.L. Nelson, and K. Torquemada. 1984. Livestock-fishery interaction studies: Tabor Creek, Nevada. USDA, Forest Service, Intermountain Forest and Range Experiment Station, Boise, Idaho. 67 p.

PLATTS, W.S., R.J. Torquemada, R.L. Nelson, and K. Torquemada. 1983. Livestock-fishery interaction studies: Tabor Creek, Nevada. USDA, Forest Service, Intermountain Forest and Range Experiment Station, Boise, Idaho. 66 p.

LITERATURE CITED

BOHN, C. 1989. Management of winter soil temperatures to control streambank erosion. In: R. E. Gresswell, B. A. Barton, J. L. Kershner, and K. A. Hashagen. Proceeding: Practical Approaches to Riparian Resource Management; an Educational Workshop. USDI, Bureau of Land Management, 222 North 32nd Street, Billings, Montana 59107. 193 p.

CLARY, W.C., and Webster, 1989. Managing grazing of riparian areas in the intermountain region. USDA, Forest Service, Intermountain Research Station, Ogden, Utah, General Technical Report INT-263, 11 p.

CONTOR, C.R. 1989. Diurnal and nocturnal winter habitat of juvenile rainbow trout in the Henry's Fork of the Snake River, Idaho. Idaho State University, Pocatello, Idaho, MS. 70 p.

CRISPIN, V.A. 1981. Stream rehabilitation of the West Fork, Deer Creek, Nevada. USDI, Bureau of Land Management, Elko District, Nevada. 30 p.

JACKSON, W.L. 1985. Analysis of structural alternatives: North Fork Cottonwood Creek riparian restoration project. USDI, Bureau of Land Management, Denver Service Center, Denver, Colorado. 15 p.

JENSON, S., R. Ryel, and W.S. Platts. 1989. Classification of riverine/riparian habitat and assessment of nonpoint source impacts: North Fork Humboldt River, Nevada. Unpublished report on file, USDA, Forest Service, Intermountain Research Station, Boise, ID.

PLATTS, W.S., C. Armour, G.D. Booth, M. Bryant, J.L. Bufford, P. Cuplin, S. Jensen, G.W. Lienkaemper, G. Minshall, S. Monsen, R.L. Nelson, J. Sedell, and J.S. Tuhy. 1987. Methods for evaluating riparian habitats, with applications to management. US Forest Service General Technical Report, INT-221, US Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT. 177p.

PLATTS, W.S., K.A. Gebhardt, W.L. Jackson. 1985. The effects of large storm events on basin-range riparian stream habitats. Presented at the North American Riparian conference, Tuscon, Arizona, April 16-18, 1985.

PLATTS, W.S., W.F. Megahan, and G.W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. US Forest Service General Technical Report INT-138, US Department of Agriculture, Forest Service, Intermountain Research Station, Ogden, UT. 70p.

PLATTS, W.S., and R.L. Nelson. (in press). Stream canopy and its relationship to salmonid biomass in the Intermountain West. Submitted to the North American Journal of Fisheries Management.

PLATTS, W.S., and R.L. Nelson. 1988. Fluctuations in trout populations and their implications for land-use evaluation. North American Journal of Fisheries Management. 8:333-345.

PLATTS, W.S., and R.L. Nelson. 1985a. Impacts of rest rotation grazing on stream banks in forested watersheds in Idaho. North American Journal of Fisheries Management 5:547-556.

PLATTS, W.S., and R.L. Nelson. 1985b. Streamside and upland vegetation use by cattle. Rangelands. 7(1):5-7.

PLATTS, W.S., and R.L. Nelson. 1985c. Will the riparian pasture build good stream?. Rangelands 7(1):7-10.

PLATTS, W.S., and R.L. Nelson. 1983. The electronic capacitance meter: a tool for evaluating riparian-fishery habitat. North American Journal of Fisheries Management. 3:219-227.

PLATTS, W.S., R.J. Torquemada, R.L. Nelson. 1985. Livestock-fishery interaction studies: Chimney Creek, Nevada. Progress Report. USDA, Forest Service, Intermountain Forest and Range Experiment Station, Forestry Sciences Laboratory, Boise, Idaho. 75 p.

ROATH, L.R., and W.C. Krueger. 1982. Cattle grazing and behavior on a forested range. Journal of Range Management 35(3):332-338.

VINCENT, R.E. 1987. Effects of stocking catchable-size hatchery rainbow trout on two wild trout species in the Madison River and O'Dell Creek, Montana. North American Journal of Fisheries Management 7:91-105.

Table 1. Grazing history of the Tabor Creek study sites.

Year	Site 1	Site 2	Site 3	
1965-67	Grazed 6/1 to 9/15	Grazed 6/1 to 9/30	Grazed 6/1 to 9/15	
1968-75	Grazed 6/1 to 9/15	Enclosed But Grazed (Gates Open)	Grazed 6/1 to 9/15	
1976	Grazed 6/1 to 9/15	Rested	Grazed 6/1 to 9/15	
1977	Grazed 6/1 to 9/15	Rested	Grazed 6/1 to 9/15	
1978	Grazed 7/1 to 10/20	Rested	Grazed 7/1 to 10/30	
1979	Site Established; Grazed 7/1 to 9/30	Site Established; Rested	Site Established; Grazed 7/1 to 9/30	Data Collected
1980	Grazed 7/1 to 9/30	Rested	Grazed 7/1 to 9/30	Data Collected
1981	Grazed 7/1 to 9/30	Rested	Grazed 7/1 to 9/30	Data Collected
1982	Grazed 7/1 to 9/30 [3]	Grazed 5/15 to 7/15	Grazed 7/1 to 9/30 [3]	Data Collected
1983	Site Enclosed; Rested [1]	Grazed 7/15 to 9/15 [2]	Site Enclosed; Rested [1]	Data Collected
1984	Rested	Rested	Rested	Data Collected
1985	Rested	Grazed 5/15 to 7/15	Rested	Data Collected
1986	Rested [3]	Grazed 7/15 to 9/15 [3]	Rested [3]	
1987	Rested [3]	Rested [3]	Rested [3]	
1988	Rested [3]	Grazed 5/15 to 7/15 [3]	Rested [3]	
1989	Rested [3]	Grazed 7/15 to 9/15 [3]	Rested [3]	

1 Trespass grazing occured.
2 Rest rotation study initiated. Site 2 was changed from a continous rest treatment to a rest rotation system and sites 1 and 3 were changed from season long grazing to complete rest treatments. Condition of site 2 was considerably better than sites 1 and 3.
3 Assumed, actual use unknown.

Table 2. Geomorphic, riparian, and aquatic measurements; means, standard deviation and 95% confidence intervals for Tabor Creek, Nevada, 1985.

Variable	SITE I Mean	SITE I SD	SITE I CI	SITE II Mean	SITE II SD	SITE II CI	SITE III Mean	SITE III SD	SITE III CI
Water Column									
Stream Width (feet)	15.2	5.12	13.9-16.5	13.7	4.38	12.6-14.8	11.6	2.8	10.9-12.3
Stream Depth (feet)	0.4	.17	0.3-0.4	0.5	0.16	0.4-0.5	0.5	0.18	0.4-0.5
Riffle Width (percent)	52.4	34.25	43.6-61.1	50.3	34.30	41.5-59.1	62.5	33.08	54.1-71.0
Pool Width (percent)	47.6	34.25	38.9-56.4	49.7	34.30	40.9-58.5	37.5	33.08	29.0-45.9
Pool Feature	4.6	2.24	4.0-5.1	5.3	1.81	4.8-5.8	5.5	1.81	5.0-6.0
Pool Rating	2.4	1.39	2.0-2.8	2.2	1.38	1.9-2.6	2.1	1.35	1.7-2.4
Streambanks									
Bank Angle (degrees)	135.7	33.10	127.2-144.1	125.8	31.82	117.7-134.0	137.2	28.15	130.0-144.4
Bank Undercut (feet)	0.2	0.32	0.1-0.3	0.2	0.24	0.1-0.2	0.2	0.30	0.1-0.2
Bank Dpeth (feet)	0.1	0.21	0.1-0.2	0.1	0.20	0.1-0.2	0.1	0.22	0.1-0.2
Streambottom									
Fines <0.03 in. (percent)	13.8	15.12	9.9-17.7	10.3	15.55	6.3-14.3	7.9	12.88	4.6-11.2
Fines >0.03 in. (percent)	5.1	10.20	2.5-7.7	4.4	6.99	2.6-6.2	6.0	9.18	3.6-8.3
Gravel (percent)	42.7	21.57	37.2-48.2	36.5	23.10	30.6-42.4	28.0	21.88	22.4-33.6
Rubble (percent)	35.0	23.17	29.1-40.9	36.7	22.72	30.9-42.5	52.3	24.88	46.0-58.7
Boulder (percent)	3.4	5.45	2.0-8.0	12.1	11.78	9.1-15.1	5.9	9.84	3.3-8.3
Substrate Embeddedness	71.7	15.22	67.8-75.6	68.5	13.02	65.1-71.8	65.7	15.06	61.9-69.5
Instream Vegetation Cover (feet)	3.2	4.45	2.1-4.4	0.5	0.91	0.3-0.8	0.5	0.85	0.3-0.7
Riparian									
Habitat Type	11.2	4.06	10.1-12.2	12.6	3.69	11.7-13.6	11.4	3.81	10.4-12.3
Bank Cover Stability	64.2	16.53	60.0-68.4	58.9	20.06	53.8-64.1	56.3	17.70	51.8-60.9
Stream Cover	1.8	0.65	1.7-2.0	1.9	0.57	1.7-2.0	1.7	0.76	1.5-1.9
Bank Alteration (percent)									
Natural	39.6	12.49	36.4-42.8	30.2	9.73	27.7-32.7	46.2	13.80	42.7-49.7
Artificial	3.4	2.27	2.8-3.9	15.7	8.03	13.6-17.8	5.5	4.46	4.3-6.6
Total	43.0	13.09	39.6-46.3	45.9	10.82	43.1-48.7	51.7	14.38	48.0-55.4
Vegetative Overhang (feet)	1.4	1.48	1.0-1.8	0.4	0.91	0.2-0.7	0.4	0.56	0.2-0.5
Vegetation Use (Percent)	0.0	0.00	0.0-0.0	52.9	16.37	49.7-58	6.0	6.04	4.4-7.5

Table 3. Annual streamside herbage analysis calibration results (gram equivalents are given parenthetically), Tabor Creek, Nevada: equations are of the linear form y = a + bx, exceptions noted.

Year	Sample Size (n)	Constant (a)	Regression Coefficient (b)	Coefficient of Determination (r^2)	Standard Error of Estimate (sy.x)
1979	16	-0.311 (-8.81)	0.074 (2.11)	0.89	0.52 (14.64)
1980	14	-0.102 (-2.45)	0.087 (2.45)	0.89	1.09 (30.19)
1981	16	-0.118 (-3.35)	0.054 (1.53)	0.83	0.30 (8.39)
1982	16	0.029 (0.833)	0.072 (2.03)	0.89	0.73 (21.14)
1983	15	-0.762 (-21.6)	0.100 (2.84)	0.89	0.58 (16.49)
1984	18	-0.844 (-23.93)	0.084 (2.39)	0.89	0.90 (25.64)
1985	15	(-30.18)	(2.76)	0.77	
1985 [1]	15	Weight (grams) = 1.021796 (Meter-reading $^{1.062751}$)		0.93	(0.83)

1 Non-Linear Model

Table 4. Annual phytomass and utilization by visual and herbage meter techniques, Tabor Creek, Nevada.

Year	Month Sampled	Phytomass in Site 1 lb/ac	Phytomass in Site 1 kg/ha	Phytomass in Site 2 lb/ac	Phytomass in Site 2 kg/ha	Pecent Use in Site 1 Meter	Pecent Use in Site 1 Visual	Percent use in Site 2 Meter	Percent use in Site 2 Visual
1979	October	216	264	2055	2247	89	68	--	--
1980	September	1126	1162	5796	6496	81	72	--	--
1981	October	470	527	1251	1402	62	65	--	--
1982 [1]	August	2617	2933	3047 [1]	3415 [1]	--	85	--	70
1983	October	2082	2333	1102	1235	--	8	--	47
1984 [2]	August	4363	4891	5457	6116	--	0	--	0
1985	August	3095	3384	1300	1421	--	0	--	53

1 All sites grazed in 1982, also sites 1 and 3 were changed from continuous grazing to continous rest and site 2 was changed from continous rest to a rest rotation grazing system.
2 All sites rested in 1984.

Table 5. Summary of Annual geomorphic, aquatic, and riparian data from 1979-1985, Tabor Creek, Nevada.

Variable	SITE I							SITE II							SITE III						
	1979	1980	1981	1982	1983	1984	1985	1979	1980	1981	1982	1983	1984	1985	1979	1980	1981	1982	1983	1984	1985
Water Column																					
Stream Width (feet)	13.9	14.6	13.6	14.6	15.8	22.6	15.2	10.3	11.7	10.8	12.5	13.7	14.8	13.7	12.3	12.8	12.4	13.1	12.5	12.8	11.6
Stream Depth (feet)	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.5
Riffle Width (%)	81.4	76.5	72.3	46.4	61.2	60.0	52.4	78.6	63.0	71.9	29.1	55.1	62.8	50.3	85.5	62.3	80.3	38.1	53.6	65.7	62.5
Pool Width (%)	18.6	23.5	27.7	53.6	38.8	40.0	47.6	21.2	37.0	28.2	70.9	44.9	37.1	49.7	14.4	37.7	19.7	61.9	46.4	34.3	37.5
Pool Feature	1.0	1.0	3.7	4.6	4.9	5.2	4.6	1.6	1.3	4.7	6.5	5.0	5.3	5.3	1.0	1.0	3.8	4.6	5.0	5.1	5.5
Pool Rating	1.3	1.5	1.6	2.8	1.9	2.3	2.4	1.8	2.0	2.0	3.0	2.1	2.3	2.2	1.4	2.0	1.8	2.8	2.4	2.1	2.1
Streambanks																					
Bank Angle (degrees)	114	128	133	129	114	119	135	110	116	121	128	124	120	125	111	125	125	124	123	127	137
Bank Undercut (feet)	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Bank Dpeth (feet)	0.2	0.1	<0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1
Streambottom																					
Fines <0.03 in. (%)	11.0	7.8	4.8	6.6	8.7	18.6	13.8	16.8	9.5	8.1	7.1	4.8	8.7	10.3	8.0	8.6	4.9	4.1	7.7	9.5	7.9
Fines >0.03 in. (%)	2.9	1.1	0.2	1.7	2.4	3.0	5.1	5.5	1.5	0.2	4.8	2.6	2.8	4.4	3.1	0.4	0.4	4.1	2.2	3.5	6.0
Gravel (%)	50.2	41.0	53.4	48.9	33.1	39.2	42.7	45.3	52.0	43.7	49.5	30.5	26.4	36.5	58.9	57.7	39.6	49.5	28.4	19.9	28.0
Rubble (%)	31.1	47.9	38.2	38.3	53.1	36.2	35.0	20.1	27.7	36.3	27.1	49.3	49.9	36.7	22.6	27.9	48.2	37.0	54.8	59.6	52.3
Boulder (%)	4.8	2.2	3.2	4.5	3.3	3.0	3.4	12.3	9.4	10.1	11.5	12.8	11.3	12.1	7.6	5.5	7.0	5.3	6.9	7.6	5.9
Embeddedness	3.3	3.5	3.7	3.0	2.6	2.4	71.7[1]	2.8	3.2	3.7	2.9	2.7	2.9	68.5[1]	3.7	3.5	4.0	3.1	2.6	2.9	65.7[1]
Instream Veg. (feet)	0.2	0.4	0.2	0.5	0.4	3.7	3.2	0.7	0.7	0.1	0.9	0.7	0.5	0.5	0.4	0.2	0.5	0.4	0.4	0.4	0.5
Riparian																					
Habitat Type	13.7	11.5	13.7	15.1	N.S	N.D	11.2	13.0	12.2	14.4	14.0	N.D	N.D	12.6	13.1	11.1	13.6	16.0	N.D	N.D	11.4
Bank Cover Stability	1.7	2.2	1.8	1.8	2.4	2.9	64.2[2]	2.3	2.5	2.5	2.0	1.9	2.5	58.9[2]	1.9	2.5	2.2	2.1	2.1	2.5	56.3[2]
Stream Cover	2.0	1.9	1.8	1.7	2.0	1.8	1.8	2.0	2.0	2.1	1.6	1.7	1.7	1.9	2.1	1.9	1.9	2.1	1.7	1.7	1.7
Bank Alteration (%)																					
Natural	22	39	58	57	35	48	40	27	43	29	44	32	36	30	24	35	37	30	37	50	46
Artificial	14	17	9	8	4	2	3	7	0	8	12	13	1	16	11	18	15	20	9	3	6
Total	36	56	67	65	39	50	43	34	43	37	56	45	37	46	35	53	52	50	46	53	52
Veg. Overhang (ft)	0.11	0.04	0.10	0.16	0.21	0.8	1.0	0.42	0.46	0.53	0.28	0.08	0.36	0.4	0.26	0.16	0.11	0.53	0.09	0.2	0.4
Vegetation Use (%)	68	72	65	85	8	0	0	0	0	0	70	47	0	53	68	67	63	63	15	0	6

1 After 1984, embeddedness estimates were not recorded in classes from 1-5 but in actual percent.
2 After 1984, streambank stability estimates were not recorded in classes from 1-4 but in actual percent.

Table 6. Summary of annual fish population analysis results, Chimney Creek, Nevada, cutthroat trout.

	Study Site											
	Site 1				Site 2				Site 3			
Variable	1981	1982	1983	1984	1981	1982	1983	1984	1981	1982	1983	1984
Cutthroat Trout												
Total Catch (T)	15	102	46	103	15	189	134	61	13	170	226	113
Population estimate (N)	25	103	47	103	15	189	139	61	13	170	232	114
Mean length (in)	5.10	2.54	4.45	3.01	5.15	2.32	2.38	2.94	4.75	2.28	2.36	2.50
(mm)	129.6	64.7	113.0	76.34	130.9	59.1	60.5	74.74	120.6	58.0	59.9	63.57
Mean weight (oz)	0.72	0.18	0.88	0.44	0.76	0.10	0.20	0.43	0.49	0.08	0.15	0.27
(gm)	20.5	5.2	24.9	12.9	21.6	2.9	5.8	12.2	13.9	2.3	4.2	7.6
Estimated biomass (oz/ft^2)	0.006	0.007	0.012	0.011	0.004	0.007	0.009	0.006	0.002	0.005	0.011	0.007
(oz/ft^3)	0.040	0.040	0.064	0.042	0.030	0.039	0.046	0.030	0.015	0.033	0.056	0.036
(gm/m^2)	1.820	2.216	3.662	3.233	1.310	2.042	2.662	1.962	0.720	1.544	3.372	2.273
(gm/m^3)	40.500	40.319	64.319	42.41	30.253	39.395	46.373	30.650	15.279	33.419	56.252	35.510
Estimated standing crop												
(No/ft^2)	0.008	0.040	0.014	0.024	0.006	0.065	0.043	0.015	0.005	0.062	0.074	0.028
(No/m^2)	0.090	0.429	0.147	0.259	0.060	0.702	0.459	0.160	0.052	0.665	0.795	0.301
(No/ft^3)	0.056	0.221	0.073	0.096	0.040	0.383	0.226	0.071	0.031	0.411	0.376	0.133
(No/m^3)	1.976	7.799	2.587	3.404	1.400	13.538	7.995	2.504	1.097	14.530	13.276	4.703
(No/ mi)	220	906	414	906	132	1663	1223	537	114	1496	2041	1003
Mean condition factor (K)	0.8	1.1	1.0	0.8	0.8	1.0	1.0	0.8	0.8	1.0	1.0	0.8

Table 7. Annual phytomass and utilization by visual and herbage meter tehcniques, Chimney Creek, Nevada.

Year	Month Sampled	Phytomass in Site 2 lb/ac	Phytomass in Site 2 kg/ha	Phytomass in Site 3 lb/ac	Phytomass in Site 3 kg/ha
1981	October	272	305	252	282
1982	October	1148	1287	1364	1529
1983	October	1067	1205	1168	1309
1984	August	2210	2477	1842	2064

Table 8. Summary of annual geomorphic/aquatic and riparian analyses means, Chimney Creek, Nevada.

Variable	Site 1				Site 2				Site 3			
	1981	1982	1983	1984	1981	1982	1983	1984	1981	1982	1983	1984
Geomorphic/Aquatic												
Water column												
Stream width (ft)	5.0	4.3	5.7	7.1	4.5	4.8	5.4	6.8	4.5	4.6	5.2	6.8
Stream depth (ft)	0.15	0.18	0.19	0.24	0.14	0.17	0.19	0.21	0.16	0.5	0.2	0.21
Riffle width (%)	26.4	35.1	41.2	40.5	27.2	18.0	38.5	55.0	29.1	28.6	31.4	53.7
Pool width (%)	73.5	64.9	58.8	59.5	72.8	82.0	61.5	65.0	70.9	71.4	68.6	47.3
Pool rating	3.1	2.9	2.7	1.9	2.6	3.3	2.6	1.9	2.7	3.1	2.3	1.7
Pool feature	3.0	4.3	5.0	4.9	3.1	5.2	5.0	4.3	3.0	4.8	5.0	4.7
Canopy cover (dg)	125	108	113	N.D.[1]	128	114	116	N.D.	134	110	111	N.D.
Streambanks												
Bank angle (dg)	132	140	131	136	134	133	138	140	136	138	133	140
Bank undercut (ft)	0.08	0.10	0.13	0.15	0.08	0.09	0.11	0.13	0.05	0.11	0.11	0.15
Bank water dpeth	0.03	0.04	0.04	0.07	0.02	0.05	0.04	0.05	0.01	0.04	0.04	0.05
Fisheries environment rating	0.9	1.6	1.8	N.D	1.2	1.9	1.7	N.D.	0.4	1.8	1.9	N.D.
Channel bottom width	N.D	N.D.	N.D.	31.1	N.D.	N.D.	N.D.	28.2	N.D.	N.D.	N.D.	26.9
Top bank to top bank	N.D.	N.D.	N.D.	35.5	N.D.	N.D.	N.D.	33.3	N.D.	N.D.	N.D.	34.8
Bank to channel ratio	N.D.	N.D.	N.D.	1.2	N.D.	N.D.	N.D.	1.2	N.D.	N.D.	N.D.	1.4
Streambottom												
Fines <0.03 in (%)	8.7	5.7	3.6	7.1	6.2	8.1	2.4	13.5	4.5	3.0	4.3	13.4
Fines >0.03 in (%)	3.2	2.0	4.3	7.0	0.8	4.3	2.9	5.4	1.9	2.4	2.7	6.6
Gravel (%)	66.9*	47.4	46.8	9.3*	48.4	53.1	38.9	23.8	54.5	44.2	33.1	20.4
Rubble (%)	19.4*	38.8	42.6	59.4	41.5	33.9	53.6	50.3	38.7	48.0	58.9	56.9
Boulder (%)	2.0	6.1	2.6	17.2	0.9	0.6	2.2	7.0	0.7	2.5	1.0	2.8
Substrate embeddedness	3.3	2.7	3.0	1.8	3.1	2.6	3.1	1.8	3.2	2.7	3.1	1.6
Instream vegetal cover	0.4	0.3	0.2	0.2	0.5	0.1	0.1	0.3	0.6	0.2	0.3	0.1
Riparian												
Habitat type	12.0*	9.0	N.D.	N.D.	8.5	7.5	N.D.	N.D.	10.7	10.7	N.D.	N.D.
Bank cover stability	1.6	1.5	2.6	2.1	1.5	1.4	2.2	1.9	1.7	1.9	2.5	1.7
Stream cover	1.5	1.5	1.5	1.2	1.3	1.3	1.5	1.3	1.4	1.4	1.9	1.1
Vegetaion overhang (ft)	0.07	0.20	0.08	0.08	0.08	0.15	0.13	0.07	0.02*	0.15	0.14	0.02
Vegetation use (%)	75	0	0	2	82	0	0	0	81	0	0	0
Bank alteration (%)												
natural	46	64	48	62	39	65	50	61	31*	48	41	63
artificial	20	1	1	0	23	2	0	0	17*	9	2	3*
total	66	65	49	62	62	67	50	61	48	57	43	66
Light intensity (%)	N.D.	78	N.D.	N.D.	N.D.	81	N.D.	N.D.	N.D.	79	N.D.	N.D.

* Significantly differen (P<0.05) than site 2 (mean o same year)
1 N.C -- no data.

Table 9 Geomorphic, riparian, and aquatic measurements; means, standard deviation (SD), and 95% confidence intervals for Cottonwood Creek, 1986.

		Site 1			Site 2			Site 3			Site 4		
		MEAN	SD	CI	MEAN	SD	CI	MEAN	SD	CI	MEAN	SD	CI
Stream Width	(ft)	7.2	1.27	6.6 - 7.7	6.9	1.52	6.2 - 7.6	8.3	1.89	7.4 - 9.2	7.0	1.72	6.2 - 7.8
Stream Depth	(ft)	0.2	0.08	0.2 - 0.2	0.2	0.07	0.2 - 0.2	0.2	0.12	0.2 - 0.3	0.3	0.11	0.2 - 0.3
Pool Width	(ft)	1.5	2.48	0.3 - 2.7	1.5	2.48	0.4 - 2.7	4.0	4.30	1.9 - 6.0	2.1	2.63	0.8 - 3.3
Pool Width	(%)	21.4	34.17	5.4 - 37.4	25.4	40.83	6.2 - 44.5	44.8	46.33	23.1 - 66.4	33.8	42.36	13.9 - 53.6
Riffle Width	(ft)	5.7	2.76	4.4 - 6.9	5.3	3.28	3.8 - 6.9	4.3	3.83	2.6 - 6.1	4.9	3.47	3.3 - 6.6
Riffle Widthe	(%)	78.6	34.17	62.6 - 94.6	74.6	40.83	55.5 - 93.8	55.3	46.33	33.6 - 76.9	66.2	42.36	46.4 - 86.1
Pool Rating		3.7	1.11	2.7 - 4.7	2.4	1.13	1.4 - 3.5	3.7	1.19	2.9 - 4.5	3.2	1.14	2.4 - 4.0
Pool Feature		4.3	2.87	1.6 - 6.9	3.9	2.79	1.3 - 6.4	3.2	2.60	1.4 - 4.9	4.0	2.71	2.1 - 5.9
Instream Vegetation Cover	(ft)	3.8	7.27	0.3 - 7.2	1.3	4.13	0.0 - 3.2	1.4	3.87	0.0 - 3.2	1.3	2.36	0.1 - 2.4
Boulder	(%)	0.0	0.00	0.0 - 0.0	0.0	0.00	0.0 - 0.0	0.0	0.00	0.0 - 0.0	0.0	0.00	0.0 - 0.0
Rubble	(%)	34.7	34.86	18.3 - 51.0	42.9	27.43	30.1 - 55.7	44.7	36.53	27.6 - 61.8	50.3	27.01	37.7 - 62.9
Gravel	(%)	45.0	29.11	31.3 - 58.6	36.2	29.97	22.1 - 50.2	30.2	29.25	16.6 - 43.9	30.6	17.71	22.3 - 38.9
Fines>	(%)	13.3	21.59	3.2 - 23.4	20.1	22.80	9.4 - 30.8	17.3	21.38	7.3 - 27.3	11.0	12.17	5.3 - 16.7
Fines<	(%)	7.1	11.18	1.9 - 12.3	0.8	3.73	0.0 - 2.6	7.7	14.20	1.0 - 14.3	8.1	16.08	0.6 - 15.6
Fines--Total	(%)	20.4	23.83	9.2 - 31.5	21.0	23.60	9.9 - 32.0	25.0	30.48	10.8 - 39.3	19.1	23.48	8.1 - 30.1
Embeddedness	(%)	44.8	20.82	35.1 - 54.5	64.6	16.42	56.9 - 72.3	69.6	19.58	60.4 - 78.7	58.3	15.48	51.0 - 65.5
Bank Angle		142.4	23.01	131.6 -153.1	161.1	10.52	156.2 -166.1	152.6	21.42	142.5 -162.6	133.3	30.16	119.2 -147.4
Bank Undercut	(ft)	0.2	0.33	0.0 - 0.3	0.0	0.00	0.0 - 0.0	0.1	0.15	0.0 - 0.1	0.1	0.23	0.0 - 0.2
Bank Water Depth	(ft)	0.0	0.07	0.0 - 0.1	0.0	0.00	0.0 - 0.0	0.0	0.08	0.0 - 0.1	0.1	0.14	0.0 - 0.1
Habitat Type		4.7	3.40	3.1 - 6.3	4.8	2.31	3.7 - 5.8	9.4	4.63	7.2 - 11.5	6.7	4.04	4.8 - 8.6
Stability		22.4	16.65	14.6 - 30.1	23.8	15.55	16.5 - 31.0	61.5	23.29	50.6 - 72.4	49.0	22.69	38.4 - 59.6
Total Alteration		74.3	17.19	66.2 - 82.3	83.8	12.76	77.8 - 89.7	60.5	25.39	48.6 - 72.4	66.0	16.11	58.5 - 73.5
Stream Cover		1.5	0.95	1.1 - 1.9	1.0	0.00	1.0 - 1.0	1.9	0.81	1.5 - 2.2	2.0	1.00	1.5 - 2.4
Vegetation Overhang		0.3	0.81	0.0 - 0.7	0.1	0.29	0.0 - 0.2	0.3	0.82	0.0 - 0.7	0.4	0.93	0.0 - 0.8
Vegetation Use	(%)	72.1	26.09	59.9 - 84.3	56.5	14.06	49.9 - 63.1	60.8	19.01	51.9 - 69.6	68.5	18.07	60.0 - 77.0

Table 10 Geomorphology Data for Cottonwood Creek, 1985; means, standard deviation, and 95% confidence intervals.

		Site 1			Site 2			Site 3			Site 4		
		MEAN	SD	CI	Mean	SD	CI	MEAN	SD	CI	MEAN	SD	CI
Stream Width	(ft)	6.2	1.44	5.5 - 6.9	6.3	1.73	5.5 - 7.2	8.7	2.30	7.6 - 9.8	5.6	1.31	5.0 - 6.2
Stream Depth	(ft)	0.2	0.07	0.2 - 0.3	0.2	0.11	0.2 - 0.3	0.3	0.14	0.2 - 0.3	0.3	0.15	0.2 - 0.3
Pool Width	(ft)	3.2	2.25	2.1 - 4.2	4.0	2.48	2.8 - 5.1	5.6	3.05	4.2 - 7.0	3.2	2.19	2.2 - 4.2
Pool Width	(%)	49.5	31.01	35.0 - 64.0	64.4	37.30	46.9 - 81.8	63.1	27.55	50.2 - 76.0	56.0	33.05	40.5 - 71.4
Riffle Width	(ft)	3.1	2.01	2.1 - 4.0	2.4	2.87	1.1 - 3.7	3.1	2.21	1.9 - 4.3	2.4	1.88	1.5 - 3.3
Riffle Wid	(%)	50.5	31.01	36.0 - 65.0	35.6	37.30	18.2 - 53.1	36.9	27.55	24.0 - 49.8	44.0	33.05	28.6 - 59.5
Pool Rating		2.1	1.48	1.4 - 2.8	1.9	1.12	1.4 - 2.4	2.3	1.23	1.8 - 2.9	2.0	1.36	1.3 - 2.6
Chan. Bottom Width	(ft)	14.1	4.48	12.0 - 16.1	59.7	34.22	43.7 - 75.7	27.0	26.41	14.6 - 39.4	13.2	8.14	9.4 - 17.0
Embeddedness	(%)	52.3	20.36	42.7 - 61.8	76.0	14.20	69.4 - 82.6	69.1	18.95	60.2 - 77.9	56.3	21.08	46.4 - 66.1
Bank Angle		137.6	28.64	124.1 -151.0	151.9	22.98	141.1 -162.7	143.4	23.11	132.6 -154.2	130.4	34.09	114.4 -146.3
Bank Undercut	(ft)	0.2	0.29	0.1 - 0.3	0.0	0.15	0.0 - 0.1	0.1	0.13	0.0 - 0.1	0.2	0.31	0.1 - 0.3
Bank Water Depth	(ft)	0.3	1.00	0.0 - 0.7	0.0	0.02	0.0 - 0.0	0.1	0.17	0.0 - 0.1	0.1	0.18	0.0 - 0.2
Stability		35.3	18.88	26.4 - 44.1	13.3	13.79	6.8 - 19.7	43.0	26.13	30.8 - 55.2	41.4	19.09	32.5 - 50.3
Natural Alteration		30.3	16.50	22.5 - 38.0	46.0	12.20	40.3 - 51.7	34.8	18.53	26.1 - 43.4	18.3	8.98	14.0 - 22.5
Artificial Alt.		42.0	17.58	33.8 - 50.2	43.0	11.17	37.8 - 48.2	18.3	12.06	12.6 - 23.9	38.3	18.62	29.6 - 47.1
Total Alteration		72.3	20.29	62.8 - 81.7	89.0	6.81	85.8 - 92.2	53.0	19.83	43.7 - 62.3	55.6	20.60	47.0 - 66.2
Vegetation Overhang	(ft)	0.1	0.17	0.0 - 0.2	0.0	0.00	0.0 - 0.0	0.1	0.13	0.0 - 0.2	0.1	0.35	0.0 - 0.3

Table 11. Cottonwood Creek Herbage and vegetation usage data for 1985 and 1986.

	Site 1	Site 2	Site 3	Site 4
1985				
Phytomass**				
lb/ac	201	275	1871	573
kg/he	179	245	1669	511
1986				
Vegetation				
Percent Use	72	57	61	69

** Calculated using: Weight (grams) = $0.0315397(\text{Meter Reading}^{2.00914})$ $r^2 = 0.70$ standard error of regression = 0.8339

Table 12 Fish population data from Cottonwood Creek study sites, 1985.

RAINBOW TROUT	Site 1	Site 2	Site 3	Site 4
Fish Captured	395	7	346	440
Pop Estimate	411	7	367	455
Standard Error	5.749	0.429	7.127	5.405
Lower Confidence Level	400	7	353	444
Upper Confidence Level	422	8	381	466
Total Weight (gm)	5075.1	115.4	6606.0	5587.0
Average Weight	12.8	16.5	19.1	12.7
Lower Confidence Level	11.1	7.2	16.5	11.1
Upper Confidence Level	14.5	25.8	21.7	14.3

SUCKERS	Site 1	Site 2	Site 3	Site 4
Fish Captured	3	0	0	0
Pop Estimate	3	0	0	0
Standard Error	1.516	0.000	0.000	0.000
Lower Confidence Level	3	0	0	0
Upper Confidence Level	10	0	0	0
Total Weight (gm)	101.7	0.0	0.0	0.0
Average Weight	33.9	0.0	0.0	0.0
Lower Confidence Level	0.0	0.0	0.0	0.0
Upper Confidence Level	108.1	0.0	0.0	0.0

DACE	Site 1	Site 2	Site 3	Site 4
Fish Captured	84	0	0	0
Pop Estimate	98	0	0	0
Standard Error	8.376	0.000	0.000	0.000
Lower Confidence Level	84	0	0	0
Upper Confidence Level	115	0	0	0
Total Weight (gm)	474.7	0.0	0.0	0.0
Average Weight	5.7	0.0	0.0	0.0
Lower Confidence Level	4.7	0.0	0.0	0.0
Upper Confidence Level	6.6	0.0	0.0	0.0

Table 13 Biomass and Density Estimates for fish in the Cottonwood Creek Study Sites, 1985

	BIOMASS			DENSITY		
	gm/100m	gm/100m^2	gm/100m^3	#/100m	#/100m^2	#/100m^3
Site 1						
Rainbow Trout	2887.52	1527.98	25065.34	224.74	118.92	1950.85
Sucker	55.61	29.43	482.73	1.64	0.87	14.24
Dace	302.82	160.24	2628.66	53.59	28.36	465.17
Site 2						
Rainbow Trout	63.10	32.86	539.06	3.83	1.99	32.70
Sucker	0.00	0.00	0.00	0.00	0.00	0.00
Dace	0.00	0.00	0.00	0.00	0.00	0.00
Site 3						
Rainbow Trout	3831.42	1444.86	15801.17	200.68	75.68	827.62
Sucker	0.00	0.00	0.00	0.00	0.00	0.00
Dace	0.00	0.00	0.00	0.00	0.00	0.00
Site 4						
Rainbow Trout	3159.18	1850.85	20241.12	248.80	145.76	1594.06
Sucker	0.00	0.00	0.00	0.00	0.00	0.00
Dace	0.00	0.00	0.00	0.00	0.00	0.00

Table 14. Geomorphic, riparian, and aquatic measurements for Deer Creek, 1986.

		Site 1			Site 2			Site 3			Site 4		
		MEAN	SD	CI	MEAN	SD	CI	MEAN	SD	CI	MEAN	SD	CI
Stream Width	(ft)	4.8	2.12	3.8 - 5.7	5.1	2.11	4.1 - 6.0	3.3	1.17	2.8 - 3.8	4.4	1.69	3.7 - 5.2
Stream Depth	(ft)	0.2	0.06	0.1 - 0.2	0.2	0.15	0.2 - 0.3	0.3	0.11	0.2 - 0.3	0.3	0.14	0.2 - 0.4
Pool Width	(ft)	1.0	1.32	0.4 - 1.7	1.8	1.97	0.8 - 2.7	1.6	1.47	0.9 - 2.3	2.4	1.96	1.5 - 3.3
Pool Width	(%)	18.1	18.26	9.6 - 26.7	41.4	43.24	21.2 - 61.7	52.6	45.26	31.4 - 73.8	52.9	38.87	35.2 - 70.6
Riffle Width	(ft)	3.7	1.56	3.0 - 4.4	3.3	3.23	1.8 - 4.8	1.7	1.66	0.9 - 2.5	2.0	1.64	1.3 - 2.7
Riffle Wid	(%)	81.9	18.26	73.3 - 90.4	58.6	43.24	38.3 - 78.8	47.4	45.26	26.2 - 68.6	47.1	38.87	29.4 - 64.8
Pool Rating		1.2	0.40	0.9 - 1.5	2.7	1.30	1.8 - 3.5	3.2	0.90	2.6 - 3.7	2.7	1.03	2.2 - 3.3
Pool Feature		3.8	2.56	2.1 - 5.5	5.5	1.88	4.3 - 6.7	4.8	1.91	3.7 - 6.0	3.8	2.48	2.4 - 5.2
Instream Vegetation Cover	(ft)	0.7	1.38	0.1 - 1.3	1.0	1.47	0.4 - 1.7	0.4	0.60	0.2 - 0.7	1.8	0.89	1.4 - 2.2
Boulder	(ft)	0.0	0.00	0.0 - 0.0	0.0	0.00	0.0 - 0.0	0.0	0.00	0.0 - 0.0	0.0	0.00	0.0 - 0.0
Rubble	(%)	3.8	16.77	0.0 - 11.6	1.8	5.91	0.0 - 4.5	0.0	0.00	0.0 - 0.0	4.8	21.82	0.0 - 14.7
Gravel	(%)	68.8	32.11	53.7 - 83.8	75.3	20.26	65.9 - 84.8	73.0	33.94	57.1 - 88.9	46.0	41.16	27.2 - 64.7
Fines>	(%)	13.4	24.52	1.9 - 24.9	0.5	2.24	0.0 - 1.5	2.5	11.18	0.0 - 7.7	19.3	26.84	7.1 - 31.5
Fines<	(%)	14.1	16.42	6.4 - 21.8	22.4	21.63	12.3 - 32.5	24.5	33.99	8.6 - 40.4	29.9	29.85	16.4 - 43.5
Fines--Tot	(%)	27.5	31.09	12.9 - 42.1	22.9	21.20	13.0 - 32.8	27.0	33.94	11.1 - 42.9	49.3	41.36	30.4 - 68.1
Embeddedness		71.6	24.05	60.3 - 82.9	58.0	18.50	49.3 - 66.6	64.7	23.01	53.9 - 75.5	77.0	24.77	65.7 - 88.3
Bank Angle		91.3	45.30	70.1 -112.4	94.1	41.84	74.5 -113.6	68.1	35.98	51.2 - 84.9	106.2	34.37	90.6 -121.9
Bank Undercut	(ft)	0.5	0.45	0.3 - 0.7	0.3	0.25	0.2 - 0.4	0.5	0.45	0.3 - 0.8	0.2	0.30	0.0 - 0.3
Bank Water Depth	(ft)	0.1	0.09	0.1 - 0.1	0.1	0.10	0.1 - 0.2	0.3	0.20	0.2 - 0.4	0.1	0.15	0.0 - 0.2
Bank Height	(ft)	1.9	0.68	1.6 - 2.2	1.6	0.51	1.3 - 1.8	1.7	0.57	1.4 - 2.0	1.7	0.59	1.4 - 2.1
Habitat Type		8.0	4.71	5.8 - 10.2	12.6	3.54	11.0 - 14.3	15.1	3.22	13.6 - 16.7	9.0	2.94	7.6 - 10.3
Stability		53.7	17.12	45.7 - 61.7	88.5	8.41	84.6 - 92.4	93.3	5.83	90.5 - 96.0	59.4	19.08	50.7 - 68.1
Total Alteration		92.3	52.50	67.7 -116.8	51.5	29.07	37.9 - 65.1	38.9	28.31	25.7 - 52.1	37.6	38.26	20.2 - 55.0
Stream Cover	(ft)	2.0	0.46	1.8 - 2.2	2.3	0.44	2.0 - 2.5	2.3	0.44	2.0 - 2.5	2.0	0.38	1.9 - 2.2
Vegetation Overhang	(ft)	0.2	0.21	0.1 - 0.3	0.6	0.41	0.4 - 0.8	0.7	0.46	0.5 - 0.9	0.1	0.17	0.0 - 0.2
Vegetation Use	(%)	75.7	13.50	69.3 - 82.0	0.4	1.10	0.0 - 1.0	0.3	0.92	0.0 - 0.7	79.7	18.86	71.1 - 88.3

Table 15. Fish populations data from Deer Creek study sites, 1986.

BROOK TROUT	Site 1	Site 2	Site 3	Site 4
Fish Captured	17	36	51	96
Pop Estimate	17	36	51	96
Standard Error	0.029	0.048	0.643	0.944
Lower Confidence Level	17	36	51	96
Upper Confidence Level	17	36	52	98
Total Weight (gm)	762.0	1684.8	1103.2	2496.6
Average Weight	44.8	46.8	21.6	26.0
Lower Confidence Level	35.1	35.0	15.9	19.6
Upper Confidence Level	54.6	58.6	27.4	32.4
CUTTHROAT TROUT	**Site 1**	**Site 2**	**Site 3**	**Site 4**
Fish Captured	3	1	0	0
Pop Estimate	3	1	0	0
Standard Error	0.259	0.000	0.000	0.000
Lower Confidence Level	3	1	0	0
Lower Confidence Level	4	1	0	0
Total Weight (gm)	73.6	33.3	0.0	0.0
Average Weight	24.5	33.3	0.0	0.0
Lower Confidence Level	9.6	0.0	0.0	0.0
Upper Confidence Level	39.4	0.0	0.0	0.0
RAINBOW TROUT	**Site 1**	**Site 2**	**Site 3**	**Site 4**
Fish Captured	19	15	11	20
Pop Estimate	19	15	11	20
Standard Error	0.186	0.006	0.271	0.388
Lower Confidence Level	19	15	11	20
Upper Confidence Level	19	15	12	21
Total Weight gm	816.9	555.9	343.7	795.5
Average Weight	43.0	37.1	31.2	39.8
Lower Confidence Level	31.0	22.5	17.8	33.3
Upper Confidence Level	55.0	51.6	44.7	46.3
DACE	**Site 1**	**Site 2**	**Site 3**	**Site 4**
Fish Captured	4	0	0	0
Pop Estimate	4	0	0	0
Standard Error	0.449	0.000	0.000	0.000
Lower Confidence Level	4	0	0	0
Upper Confidence Level	5	0	0	0

Table 16. Biomass and Density data from Deer Creek Study Sites, 1986.

	BIOMASS			DENSITY		
	gm/100m	gm/100m^2	gm/100m^3	#/100m	#/100m^2	#/100m^3
Site 1						
Brook Trout	416.67	284.80	4671.84	9.30	6.35	104.23
Cutthroat Trout	40.24	27.51	451.24	1.64	1.12	18.39
Rainbow Trout	446.69	305.31	5008.43	10.39	7.10	116.49
Dace	0.00	0.00	0.00	2.19	1.49	24.52
Site 2						
Brook Trout	921.26	592.65	9721.92	19.69	12.66	207.73
Cutthroat Trout	18.21	11.71	192.15	0.55	0.35	5.77
Rainbow Trout	303.97	195.54	3207.75	8.20	5.28	86.56
Dace	0.00	0.00	0.00	0.00	0.00	0.00
Site 3						
Brook Trout	603.24	599.73	6558.78	27.89	27.73	303.21
Cutthroat Trout	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow Trout	187.94	186.85	2043.38	6.01	5.98	65.40
Dace	0.00	0.00	0.00	0.00	0.00	0.00
Site 4						
Brook Trout	1365.16	1017.92	11132.15	52.49	39.14	428.06
Cutthroat Trout	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow Trout	434.98	324.34	3547.07	10.94	8.15	89.18
Dace	0.00	0.00	0.00	0.00	0.00	0.00

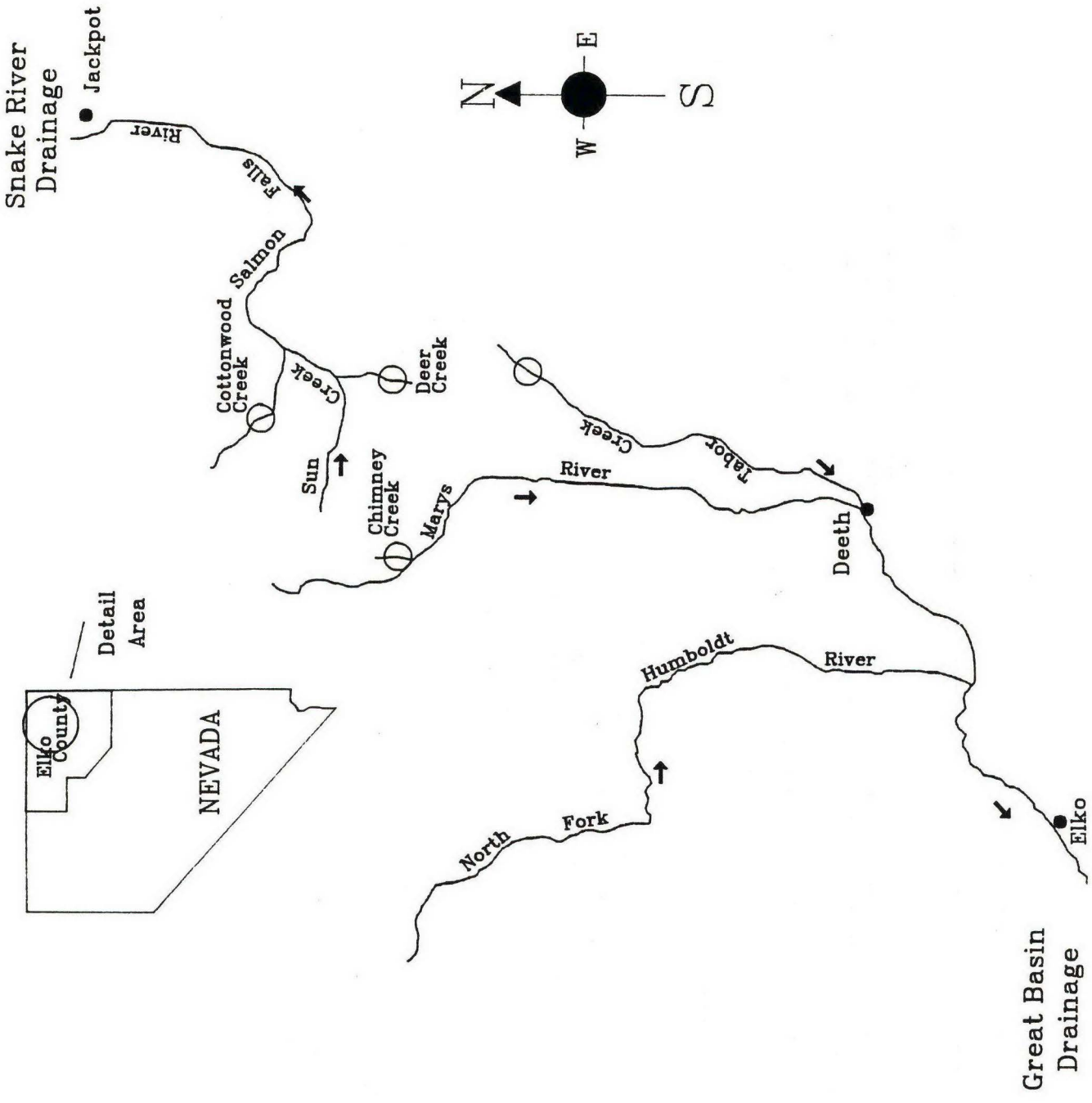

Figure 1. Location Map of Tabor Creek, Chimney Creek, Cottonwood Creek, and Deer Creek Study Sites.

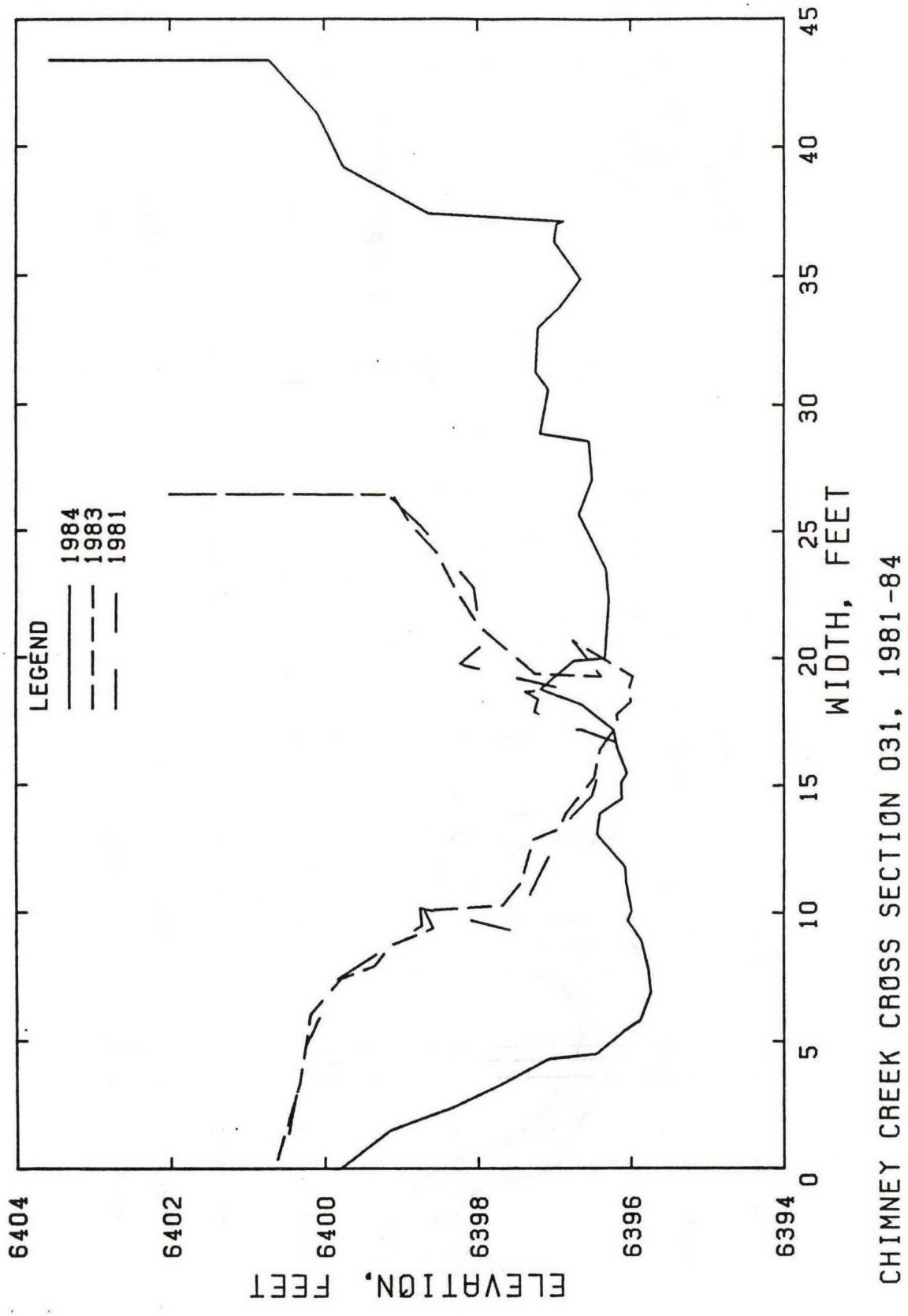

Figure 2. Channel profile from the lower site showing extensive lateral erosion.

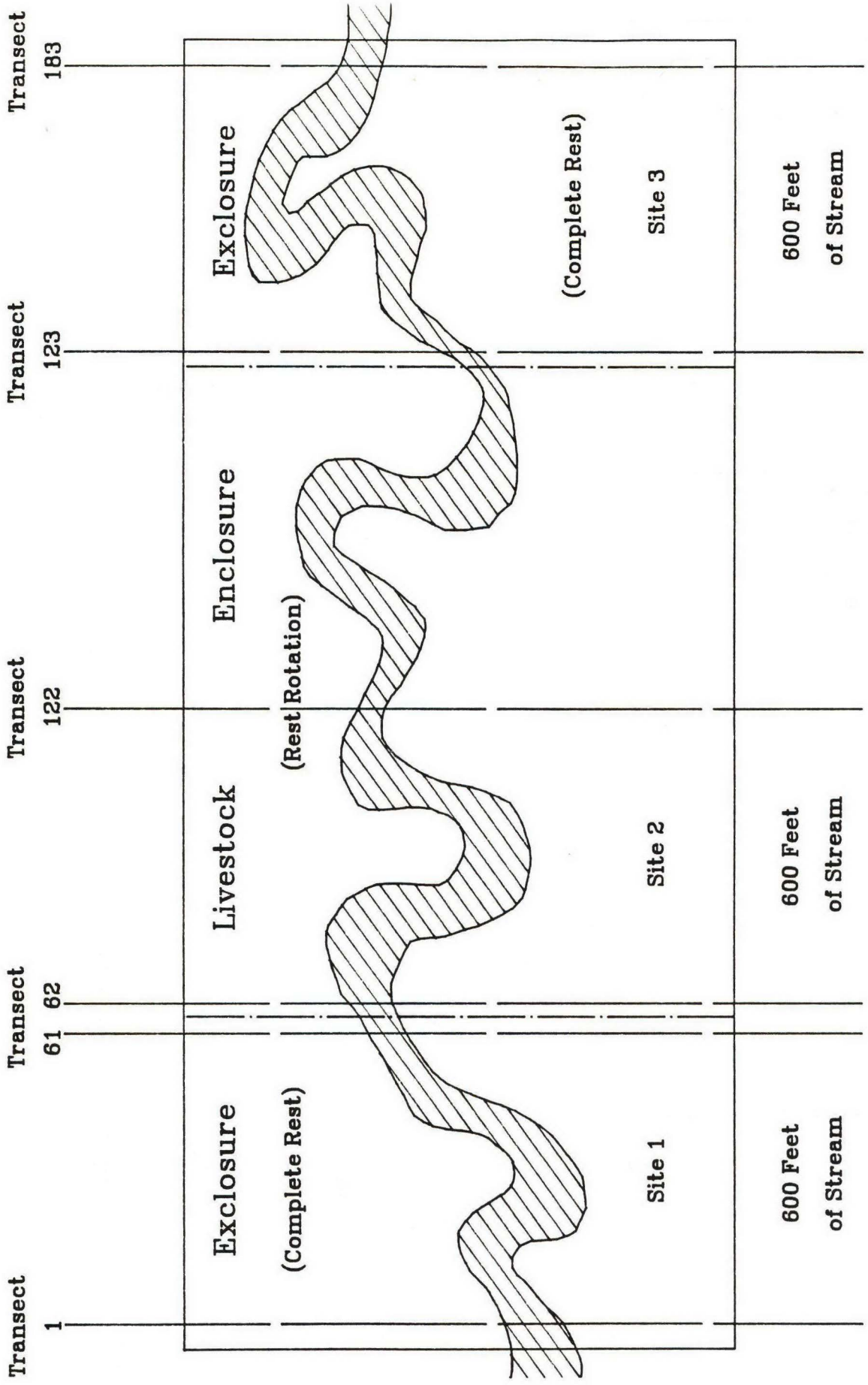

Figure 3. Tabor Creek Study Site Schematic.

Figure 4. Chimney Creek Study Site Schematic

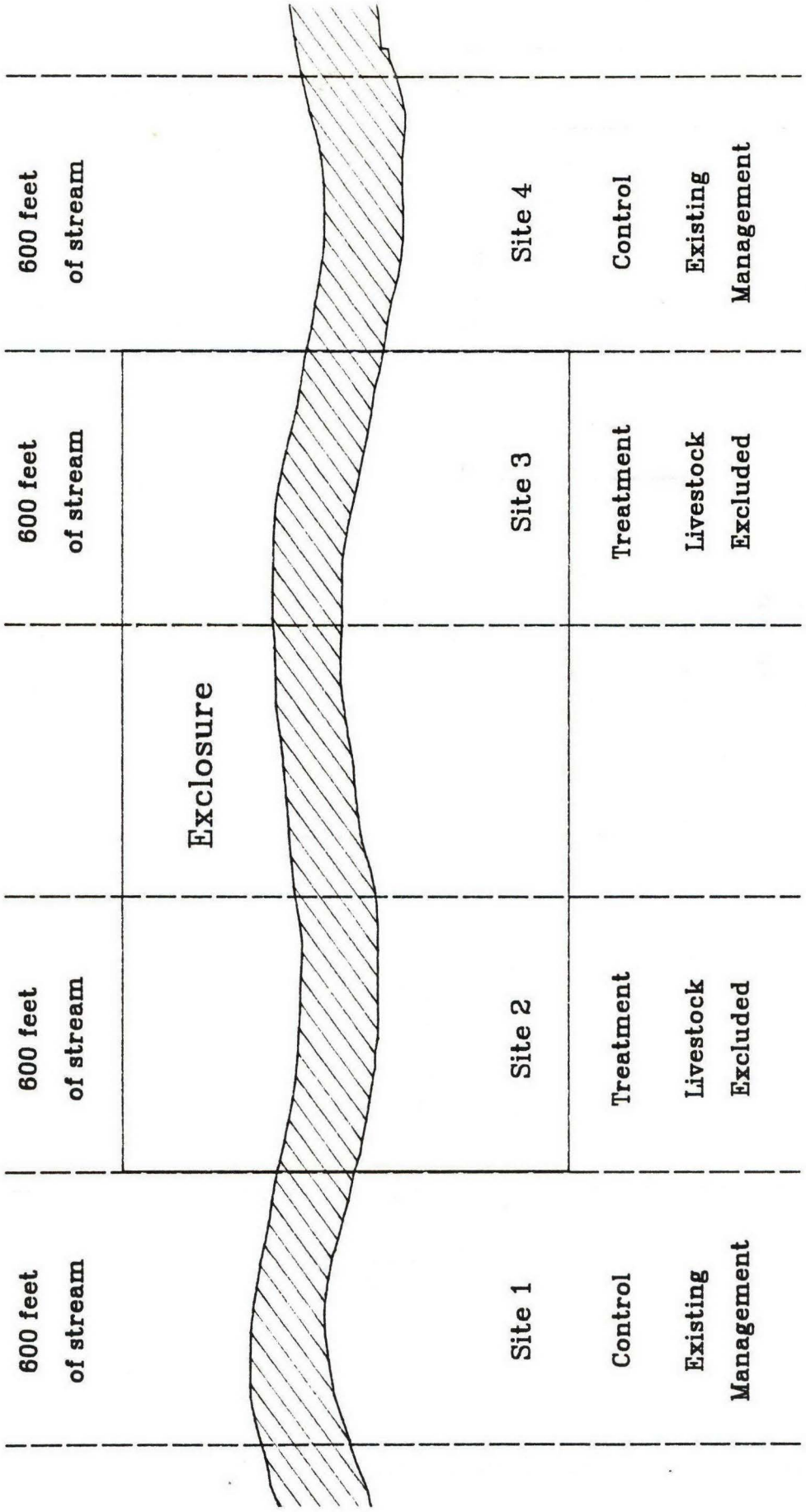

Figure 5. Study Site Schematic for Cottonwood and Deer Creek Studies.